Notes on the Life Cycle and Natural History of Butterflies of El Salvador. VI A.—*Diaethria astala* Guérin. (Nymphalidae-Callicorinae)

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Abstract: The results of observations carried on for a period of five years on one species of the Callicorinae, *Diaethria astala* Guérin, are presented. An account is given of the external morphological characteristics of the early stages, of the time elapsed in the metamorphosis, of the progressive sizes of each stage, and of the foodplants in El Salvador. The evident similarities between the early stages of this species and of *Catagramma titania* Salvin, and *C. pitheas* Latreille, on one hand, and the early stages of species belonging to the Catonephelinae are pointed out, suggesting a close phylogenetic relationship between the three groups. The probability of the species having developed impalatability against predators is deduced *a priori* from the noxious properties of the foodplants exploited by the larvae, and *a posteriori* from the brilliant coloration exhibited by the adults.

INTRODUCTION

Through several series of articles my sons and I intend to divulge the results of our observations on the early stages and adults of butterflies inhabiting the neighborhood of San Salvador, capital city of El Salvador. The present one is the sixth of the second series which was dedicated up to now to the Catonephilinae. This one deals with a species of Callicorinae, in order to evidence the close relation between the two groups which are widely accepted as Nymphalidae.

Even though two centuries ago Denis and Schiffermüller (1775) were conscious of the importance of the characteristics of the larvae as well as these of the butterflies when working up a system of the Lepidoptera, "Ein Auge auf den Schmetterling, das andere auf die Raupe," (one eye on the butterfly, the other on the larva), and modern authors still accept the validity of that concept, going even further: "any classification must take into account as many as possible of the external and internal structures not only of the adults but of the early stages" (Ford, 1945), it is evident that the early stages of many Neotropical Rhopalocera are still little known. As a result, some groupings have been arbitrarily made. We hope that our presentations will help, within their limitations, to fill the existing gap of information.

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We have reared *Diaethria astala* Guérin a number of times since early 1968 from eggs collected immediately after oviposition. Photos have been taken of them, of the subsequent larval instars and of the pupae. Record has been kept of the time spent on each individual stage and their respective measurements. Specimens of the early stages were perserved in alcohol and sent to the American Museum of Natural History, New York, where they are available to students of the group. In every instance we have reared this species, the eggs and larvae were kept in transparent plastic bags which were cleaned daily and maintained at all times under ambient light and temperature conditions. The identification of the butterfly was tentatively made by Miguel Serrano, and confirmed later by Dr. Frederick D. Rindge.

LIFE CYCLE STAGES

Egg. Truncated cone shaped. Green with 14 lighter green ribs running from base to micropylar area. Ribs alternately reach the micropyle and vanish at the edge of the dome. About .75 mm. long. Hatches in 4 days.

First instar larva. Head brown, roundish, naked. Body yellowish-green, cylindrical, naked, with annulets between segments. 1.5 mm long when recently hatched, 3 mm before moulting in 4 days.

Second instar larva. Head brown with short, stubby, knobbed horns on each epicranial apex. Body yellowish-green profusely tuberculated by minute excrescences of lighter color. A lateral spine, deflected caudad, at each side of the 9th abdominal segment. 5.5 mm long before moulting in 4 days.

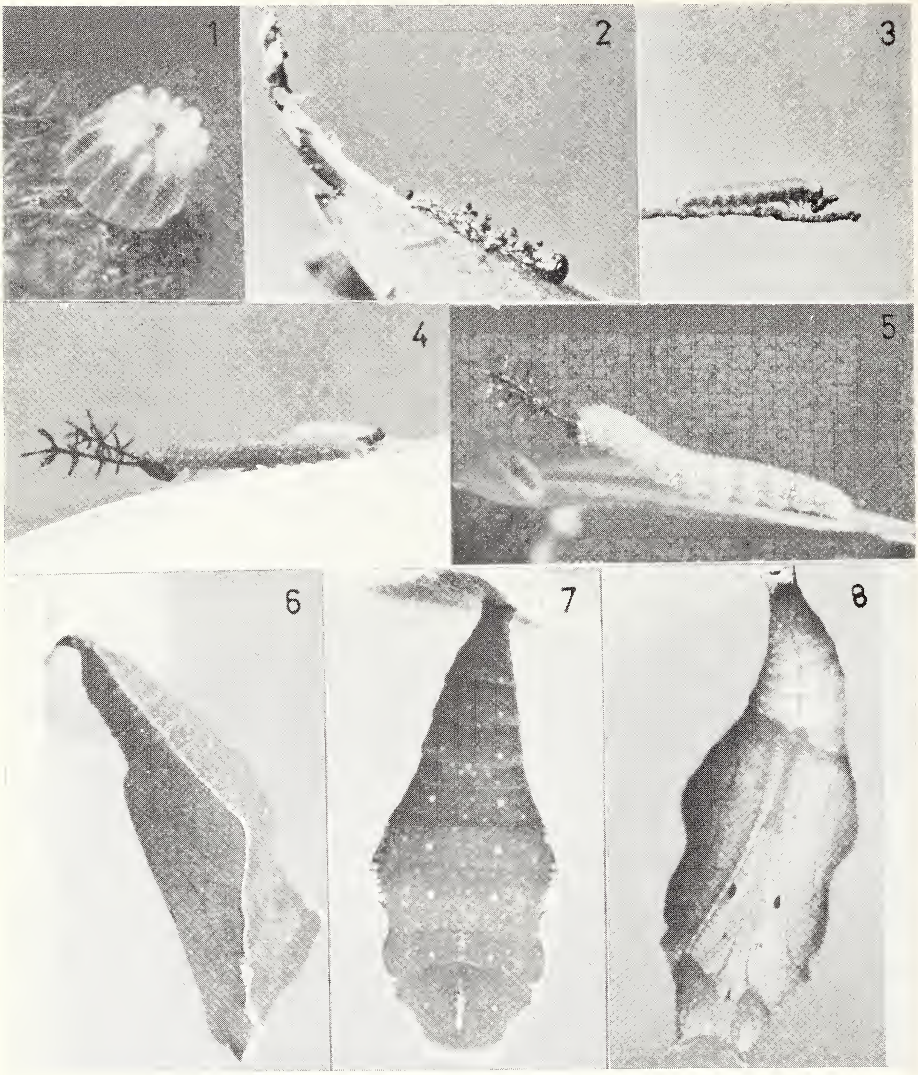
Third instar larva. Head brown, cordiform, with two long (nearly ½ of body length) slender, brown horns ornamented with three rosettes of accessory spines, bearing sparse thin setae. Body light green, finely tuberculate, with minute subdorsal, black, tri-furcated spines, from second abdominal segment to 8th abdominal segment. Lateral spines on 9th abdominal segment more developed and yellowish. About 10 mm long (not counting the horns). Moults in 6 to 8 days.

Fourth instar larva. Head and body as in third stadium, but horns ⅓ of body length, and subdorsal spines on yellow pinnacula. Grows to 15 mm in 5–7 days.

Fifth instar larva. Head reddish at base of horns and lateral margins, whitish in front. Horn shafts alternately reddish brown and dirty white. Accessory spines on horns bearing sparse dark setae at tips. Body light green with a scattering of tiny white tubercles and three rows of yellow tubercules, one along meson from 1st to 7th abdominal segments, and two subdorsally from 2nd thoracic segment to 8th abdominal segment. The subdorsal tubercules bear each a small but prominent black spine and two smaller ones. The median tubercules each bear one small black spine. The lateral furcated black spines on 9th abdominal segment are very prominent now on yellow scoli. Grows to 25 or 27 mm in 6–7 days.

Prepupa. No changes in appearance, but shorter. One day.

Pupa. Abdomen thickening from brown flat cremaster to wing cases. Indentation separating abdomen from humped and keeled thorax dorsally, terminating in bifid head. Color



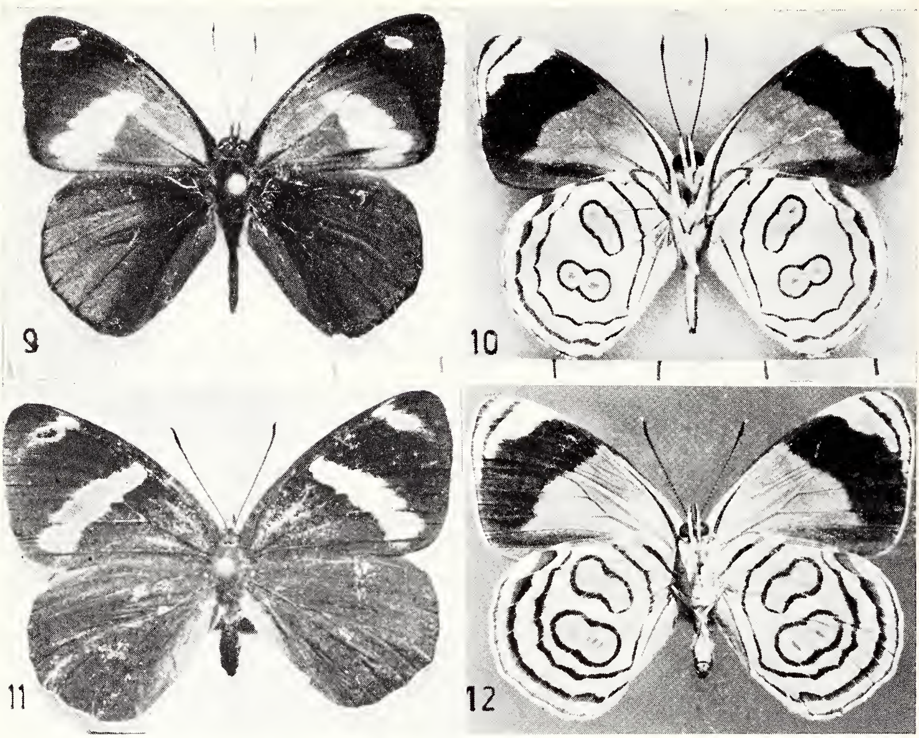
FIGS. 1–8. *Diaethria astala* Guérin. 1. Egg. 2. First instar larva with frass pellets stuck to its body. 3. Second instar larva on its perch, ready to moult. 4. Third instar larva. Notice body parallel to leaf. 5. Fifth instar larva with anterior part of the body raised. 6. Pupa. Lateral view. 7. Pupa. Dorsal view. 8. Pupa. Ventral view.

green with brown lining laterally from cremaster, wing cases and head. Thin brown vein-like markings ventrally on wingcases, and two dark spots about midway along the antennae. Spiracula small and inconspicuous green. The whole dorsal surface covered by very short, golden hair visible under a 10 × magnification only. Wingcases turning dark before adult emergence. Duration 5–6 days.

Adults. There is sexual dimorphism in this species, even if not so drastic as in some Catonephelinae. The shape of the wings is the same in both sexes: front wing with a slightly convex costal margin, rounded apex, almost straight outer margin, rounded tornus and slightly concave inner margin. Hindwing almost round, with a humeral lobe and a fold at inner margin. Dorsal ground color of both fore- and hindwings is in both sexes velvety black, which in males gives a deep blue reflexion under direct sunlight. In front wings of males there is an iridescent blue slanting bar arising from inner margin, near tornus, towards mid-costal margin, disappearing around discal cell, and a white spot subapically. On females the slanting bar is narrower, iridescent greenish-blue and almost reaches the costal margin; there are two subapical white spots instead of one. Ventrally both sexes have the same striking combination of colors: forewing with a small gray basal area, followed by a triangular red zone lined by dark gray band along inner margin, then a thick, dull-black band from mid-costal margin to tornus, finally an apical white triangle with two thin black lines parallel to outer margin. Hind wing mostly white with the characteristic gray "89" surrounded by a thin black line; another thin, red line parallel to the black line midway between it and outer margin. Body black dorsally, white ventrally. Dark brown eyes and black, white-ringed antennae. Wing span averaging 44 mm in males, 50 mm in females. Total developmental time varies from 35 to 41 days.

NATURAL HISTORY

Oviposition in this species occurs usually between 10 and 15 hours. The females fly to the foodplant rather hesitantly. Once the foodplant has been located, they fly around a few times until a suitable place is chosen and alight on a mature leaf or a tender terminal. A single egg is deposited per location, either on the edge of a mature leaf or on the tendrils or terminal bud of a young shoot. Once the egg is deposited the females resume the circling flight and the process is repeated several times before moving away. We have seen eggs being laid from almost ground level on small rampant plants (which is the most usual method), to about 16 m from the ground on the young terminals of plants clinging to neighboring trees. This is done on vines belonging to the Sapindaceae; the genera *Serjania* and *Cardiospermum* seem to be preferred, even though we have collected eggs and larvae of *D. astala* on *Paullinia* spp. eventually. The eggs, due to their small size and green color, are rather hard to find. The tiny hatching larvae eat an exit hole through a wall of the eggshell, and at times eat afterwards a portion of the upper part of it, but always leaving an identifiable remnant. The small larvae move later to the edge of the leaf and feed on it, usually around a vein, which is prolonged with frass pellets affixed with silk, and this is used by the larvae as a resting place while not feeding. It is common to find small larvae with one or several pellets stuck to their own bodies. This might function as camouflage or to have material at hand to lengthen the perch as needed. The small larvae usually hold to the perch with just the prolegs, raising the anterior part of the body, the head pointing distally. Second instar larvae behave similarly. The larvae during these stadia leave the perches only to feed, which is done early in the morning or



Figs. 9–12. *Diaethria astala* Guérin. 9. Male dorsal side. Measures in cm. 10. Male ventral side. 11. Female dorsal side. 12. Female ventral side.

late in the afternoon, and once this is done they crawl back to the resting places. While walking, the larvae weave a foothold of silk, moving the head from side to side. From third instar on, the larvae abandon the perch and wander about the plant, usually on the upper surface of the leaves. Most of the time they stay motionless adopting two peculiar attitudes, one with the whole body in contact with the leaf surface, the head bent forward so that the horns are parallel to the leaf surface; and a second with only the abdominal segments parallel to the leaf surface, the thoracic segments raised, but as before the head bent forward in a similar manner. When the observer blows on a larva resting as described, it reacts by a continuous twitching motion of the thoracic legs. If prodded with a sharp object, the larva strikes violently with its horns. When by accident more than one larva move to the same leaf, a fight is certain to occur as one larva touches the other. As a rule one or both contendants will be punctured by the sharp spines of the horns, or their horns will lock in such a way that both larvae will not be able to feed and therefore will starve. One time we found a fifth instar larva moving about the plant with a dead third instar larva looped around its thoracic segments, the horns of both larvae being firmly interlinked. The younger and weaker larva had succumbed to starvation while still fighting to disentangle its horns. The bigger larva died few days later as a result of an infection caused by the decaying body of the smaller one, although due to its greater strength it could feed normally.

When ready to pupate, the larvae look for a convenient place on the same vine or on a neighboring shrub or small tree and weave a silken pad usually on the upper surface of a leaf, less commonly on the lower surface, clean the digestive tract and hold to the silk with the anal prolegs. The larvae very seldom hang to pupate. The pupae in consequence, may be on either surface of a leaf, not hanging, but closely appressed to it. The pupae when disturbed can produce a faint creaking sound by wiggling sidewise or moving accordion-like. Shortly before the adult emergence the green pupae turn dark gray and the dorsal colors of the wings are visible through the shell.

The emerging adult rapidly abandons the pupa shell and hangs from it until the wings are rigid enough to fly, meanwhile expelling a rusty meconium. We have never observed the adults while in copula, nor have we seen them feeding on flowers nor on fermenting fruits, even though we suspect they do feed on the latter; but very often we have collected adults on vertebrate excrements or at mud puddles alongside creeks. When approached the butterflies fly swiftly in circles, their bluish flash being very conspicuous.

The foodplants of *Diaethria astala* larvae we have found up to the present all belong to the Sapindaceae, genera *Paullinia* (*P. pinnata*), *Serjania* (several species) and *Cardiospermum* (*C. halicacabum*). Many plants belonging to the genera *Paullinia* and *Serjania* are reported by various authors (Standley, 1924; Beille, 1909; Baillon, 1874) to contain poisonous or narcotic properties. *Cardiospermum halicacabum*, according to Beille (1909), is rich in saponine. All these plants are widely distributed in El Salvador. We have found them mostly between 500 and 1500 m along ravines and creeks which harbor very disturbed second growth plant communities in this densely populated country, whose land is almost completely under intensive cultivation. It is within this range (500–1200 m) that *Diaethria astala* is found. The adults favor the neighborhood of coffee plantations, ravines and creeks with heavy vegetation.

When rearing this species we have lost many individuals due to parasitism, usually by Tachinidae, but also by Hymenoptera. Others died when fed on slightly decaying leaves of the foodplants, which seem to become more toxic even for them.

DISCUSSION

Müller (1886) gives a description of the early stages of *Callicore meridionalis* Bates, using *Myscelia orsis* Drury as comparison model; and of *Catagramma* *pygas* Godart comparing it with *C. meridionalis* which is cited by J. Röber (1915). Müller in his work reports the foodplant for *C. pygas* to be *Allophylus petiolatus* Radlkofer, (Sapindaceae), and amazingly *Trema micrantha* Dell, (Ulmaceae he places under Urticaceae), for *Callicore*. This is repeated by Röber (1915), by Bates (1923) for *Diaethria clymena* (Cramer) and quoted by Kimball (1965). *Trema micrantha*, a small tree, is found in this country in the same habitats in which we find the Sapindaceae vines used by *Diaethria astala* (as well as other species: *D. salvadorensis* Franz, *Catagramma titania* Salvin, *C. pitheas* Latreille) larvae as foodplants, yet not a single time have we found, or have been able to make the larvae accept *Trema micrantha* as food. Was a Sapindaceae tree misidentified? In any case, the species we have reared, feed locally and exclusively on a variety of plants of the family Sapindaceae. In our knowledge, this is the first time a complete description of the life cycle of *Diaethria astala*, illustrated with photographs, is presented.

Ebert (1969) lists under Callicorinae: *C. sorana* Godart, *Diaethria candrena* Godart, *D. clymena*, *D. eluina* Hewitson and *Paulogramma pyracmon* Godart as species existent in the Brazilian zone of Poços de Caldas, Minas Gerais. We do not find any *Catagramma* listed in that group, or in the closely related Catonephelinae. After having reared *Catagramma titania* from the egg and *C. pitheas* partially, we dare to suggest Callicorinae and Catagramminae are at least as closely related as Catonephelinae and Callicorinae, (if they should not be all aggregated into a single family, probably Catagrammidae, as Guenée and Burmeister did, separating the groups into subfamilies or tribes), as there is a great similarity between the eggs, larvae and pupae of *Catagramma titania* (and what we have seen of *C. pitheas*), and those of *Diaethria astala* and *D. salvadorensis*, (the latter using the same foodplants as *D. astala* but at higher altitudes: 1200 m and up). One time we observed a *C. titania* ovipositing on the young terminals of a *Serjania* vine high up in a supporting tree (16–20 m). The terminals were brought down and placed in a transparent plastic bag. Some greenish eggs were found on the younger parts of the terminals, along with some yellow ones, and under superficial examination were found similar, the difference of coloration being attributed to different ages, and all were reared to adult. To our surprise two kinds of larvae were noticed when at third stadium: some typical *Diaethria* and others without the tiny subdorsal spines, but with a thick scolus and with spines on meson of 8th abdominal segment! The head and its horns, the body shape and color, and the behavior of these larvae were almost the same as those of *Diaethria*. The pupae formed later were all also very similar. Some of these produced adults of *C. titania* others of *D. astala*. It is accepted that the egg, larval and pupal characteristics are the ones which resist to a greater degree the changes induced by divergent selection, and therefore are of extreme importance to determine phylogenetic relationships between species, genera and families. In this case they seem to indicate the close relationship of *Catagramma-Diaethria*. As a result of the comparison of the external characteristics of the eggs, larvae and pupae of the two genera, reinforced by the similar behavior and the same foodplant association, we conclude that the two groups also evidence a close affinity with Catonephelinae. We refer to the descriptions of the early stages and behavior of *Catonephele numilia esite* Felder (Muyshondt, 1973), *Epiphile adrasta adrasta* Hewitson (Muyshondt, 1973a), *Temenis laothoe liberia* Fabricius (Muyshondt, 1973b) *Pseudonica flavilla canthara* Doubleday (Muyshondt, 1973c) and *Pyrrhogyra hypsenor* Godman & Salvin (Muyshondt, 1974) to support our contention, without having to be repetitious.

In our presentation of the Catonephelinae mentioned above we discussed the probability that at least some of them (*E. adrasta*, *T. laothoe*, *Pseudonica flavilla* and *Pyrrhogyra hypsenor*), which also feed on Sapindaceae, have developed a more or less strong impalatability to predators, basing our assertion not only on the poisonous properties of the foodplants, but on the gradually showier colors and slower flights these species show, following the sequence as above. Being that *Diaethria astala* larvae feed on the same plants the others do, that they behave similarly during the early stages and most of all that the adults have a brilliant coloration, we also suggest the probability of this species being protected against predation for the same reasons. In addition to this defense mechanism based on chemical properties, the adults of *D. astala* exploit the contrasting dorsal and ventral bright colors to produce a bewildering effect on attackers of "flash-and-substitute," as the fast moving blue streak suddenly disappears when the butterflies alight with their wings folded, and are replaced by an altogether different and immobile object, however bright and gaudy their coloration. In no case could these colors be considered cryptic or camouflaging, but on the contrary they seem to advertise the noxious properties of the butterflies to their potential enemies.

Diaethria astala is another species which appears to support our hypothesis that parasitizing Diptera and Hymenoptera will prefer hosts protected from predation as a means to guarantee the survival of their progeny, (Muyshondt 1973b, c and 1974) because this species also is decimated mostly by tachinid flies. We have found pupa shells in the fields also clearly showing exit holes similar to the ones caused by *Spilochalcis* sp. on pupae of *Pyrrhogyra hypsenor* in our insectarium.

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